Kentallenite with Unusual Mica from Torigoe, Japan

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BY

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With 3 Text-figures.

INTRODUCTION.

Last year (1912) I had an opportunity to take notice of an interesting rock specimen in one of the collections preserved in the Geological Survey of Japan. This was collected by Mr. S. NAKAMURA in 1908, at Torigoé,[1] a small village, at 2 km. north of Ichi-no-he,[2] which is a country town in the province of Mutsu[3] and situated on the railroad connecting Tokyo and Aomori. He made a brief description of this rock in his report "Explanatory Text to the Geology of the Ichinohe-Sheet"[4] under the name of olivine gabbro. According to him the rock occurs as a small mass cutting the Paleozoic formation and covered by the Tertiary sediments and is a differentiated facies of hornblende-granite.

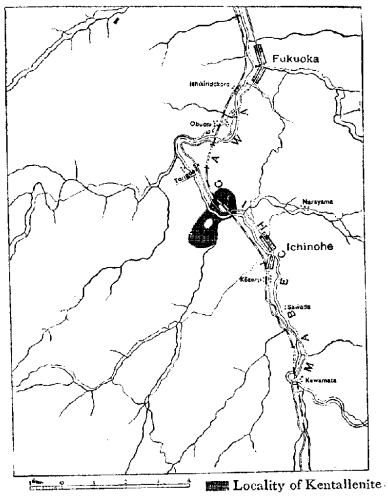

Fig. 1. Sketch map showing the locality of Kentallenite.

I have not yet had an opportunity to learn by my own inspection the geological and petrographical relation of the rock mass in the field, but as this kind of rock was not yet noted in Japan, especially in Northern Japan, and moreover the brown mica contained in it is quite different in optical characters from those which have ever been studied, I found worthy to make its brief description in the following lines though based upon the observation of only a single specimen.

With regards to the geological age of the rock mass, nothing could be said at present with precision, except that its intrusion happened at a certain time in the long interval between the Paleozoic and the Tertiary, for no formation between these two periods being yet known in the extensive tract surrounding Torigoé, in which the granitic rock and its allies are found in many exposures. A single case exceptional to this general rule is first met with in the Miyako district, some 120 km. distant east of the place now in consideration, where we got very recently an important information in this connection through

1) 鳥越. 2) 一ノ戸. 3) 陸奥.

4) "Ichinohe-Sheet" covers an area lying within 40°–40° 30′ N. lat. and 141°–142° E. long. Such division being made by the Geological Survey for the sake of convenience in geological research. His report written in Japanese and the geological map of the scale 1: 200,000, both in Japanese and English, were published by the Survey in 1911.

the interesting paper by Prof. H. YABE and Mr. S. YEHARA on the Cretaceous deposits.[1] According to the personal observation of the latter, the age of the intrusion of the granitic rock there prevailed is undoubtedly post-Lower Cretaveous and pre-Middle Cretaceous. Although there is no positive evidence indicating the direct relation existing between the Torigoé rock and the granitic rock of Miyako district, yet it seems highly probable that they are contemporaneous.

My thanks are due to the director of the Geological Survey, who placed the specimen at my disposal and to Mr. K. YOKOYAMA, who kindly undertook the chemical analysis of the rock in the chemical laboratory of the Geological Survey of Japan.

Petrographical Character.

Mineralogical character:—The rock is phanerocrystalline, evenly granular, and medium grained. It is dark gray in color and has a semiwaxy lustre, owing to the presence of alkaline feldspar. The alkaline feldspar shows a beautiful schillerization of a blue tone. The minerals recognizable by the naked eye are feldspar, black mica and pyroxene.

Fig. 2.
Microphotograph of Kentallenite, showing all ingredients of the rock, olivine, augite, brown mica, magnetite and feldspars. × 18.

Fig. 3.
Microphotograph of Kentallenite between the crossed nicols, showing plagioclase and alkali feldspar. × 40.

Under the microscope, the rock consists essentially of alkaline feldspar, plagioclase, augite, olivine, brown mica and magnetite, with apatite as accessory.

The alkaline feldspar and mica are anhedral in form, and the olivine and augite show a tendency toward automorphic form. This character is more prominent in plagioclase.

The alkaline feldspar is the last product of crystallization and fills up the interstitial space between the other ingredients. Its quantity is fairly large. Some of the mineral shows single twinning, according

1) The Cretaceous Deposits of Miyako. The Science Report of the Tohoku Imperial University, Sendai, Japan. Vol. I, No. 2, 1913.

to the Carlsbad law. The distinguishing character from normal orthoclase is in its higher refractive index (the minimum index of refraction lies between 1.520 and 1.525, and the maximum index of refraction between 1.525 and 1.530). The extinction angles measured on (010) of cleavage pieces are 7° to 9° in the obtuse angle. No microcline structure or undulatory extinction can be observed and the axial angle is larger than that of anorthoclase. From these characters the feldspar may be identified as a variety of soda orthoclase. As inclusions, quartz appears poikilitically in its crystal form or in a worm-like shape, and andesine in small crystals is arranged with the same orientation.

The plagioclase as an essential ingredient of the rock belongs to calcic andesine with chemical composition of Ab_{47} An_{53}, determined by the refractive indices (the minimum index of refraction is 1.553 and the maximum index of refraction 1.561). It is polysynthetically twinned and its form is an elongated prism.

The augite is a pink colored and titaniferous variety. The optical properties are as follows:

α	1.696	$\gamma-\alpha$	0.023
β	1.701	$\gamma-\beta$	0.018
γ	1.719	$\beta-\alpha$	0.005

$2V$ ..... 53°

$\dot{c} \wedge c$ ..... 51° in obtuse

Optical character ..... positive.

The values of α and β were determined by the standard liquids which are prepared in the geophysical laboratory of the Carnegie Institution and $2V$ under the microscope by WRIGHT'S method; and from these data γ was obtained graphically.

The brown mica is noteworthy for its unusually high refractive indices which are much larger than those for any mica having ever been described, so far known as to the writer. These are given below:—

α	1.589	$\gamma-\alpha$	0.067
β	1.653	$\gamma-\beta$	0.003
γ	1.656	$\beta-\alpha$	0.064

$2E$ ..... 47.5°

Optital character ..... negative.

Pleochroisms
- a ..... light orange yellow.
- b ..... chestnut brown.
- c ..... yellow ochre.

Absorption ..... $b > c > a$

The olivine which is one of the essential ingredients of the rock is very faintly yellow and is irregularly outlined, with a tendency toward automorphism. The characteristic cracks traversing the mineral are prominent and along these fissures greenish material can be seen as the product of decomposition. The mineral is frequently enclosed by augite, but the reverse case is not rare. The maximum refractive index lies between 1.695 and 1.700.

The magnetite is mostly subhedral, with small euhedral crystals occurring exceptionally. The large crystals usually occur in association with brown mica and augite, and are sometimes fringed by augite fibers.

Chemical character:—The chemical analysis of the rock from Torigoé, made by K. YOKOYAMA in the chemical laboratory of the Geological Survey of Japan, is given below. For comparison, other analyses of the rocks from the different localities, which show close relations with that of the Torigoé, are cited in parallel columns.

	I	II	III
SiO_2	51.38	52.09	51.68
Al_2O_3	14.80	11 93	14.07
Fe_2O_3	1.76	1.84	4.71
FeO	7.67	7.11	4.57
MgO	6.48	12.48	7.72
CaO	8.15	7.84	6.65
Na_2O	2.35	2.04	2.45
K_2O	4.45	3.01	4.16
H_2O	1.15*	0.35	2.09
CO_2	...	...	...
TiO_2	1.54	0.74	1.08
P_2O_5	0.63	0.34	0.72
SO_3	...	...	0.13
Cr_2O_3	...	0.10	...
MnO	0.08	0.15	trace
NiO	...	0.07	...
Li_2O	...	...	trace
Sum	100.44	100.24	100.03

* Loss on ignition.

I. Kentallenite, Torigoé, Prov. Mutsu, Japan. K. YOKOYAMA analyst.
II. Kentallenite, Glen Shira, Argyllshire, Scotland. W. POLLARD analyst.
III. Absarokite, Two Ocean Pass, Yellowstone National Park. J. E. WHITFIELD analyst.

The norms, which can be obtained by calculation from the above analyses, are as follows:

	I	II	III
Orthoclase	26.1	17.8	25.0
Albite	19.4	16.8	16.8
Anorthite	16.7	14.7	13.6
Nepheline	0.3	...	...
Diopside	16.8	19.4	14.4
Hypersthene	...	14.9	21.0
Olivine	13.3	12.3	...
Magnetite	2.6	2.8	7.0
Ilmenite	2.8	1.4	0.9
Apatite	1.2	...	1.4

The ratios of the norms of the Torigoé rock are:

$\frac{Sal}{Fem}$ ..... $\frac{62.5}{36.7} = 1.71$

$$\frac{L}{F} \quad \cdots\cdots \quad \frac{0.3}{62.2} = 0.005$$

$$\frac{Na_2O' + K_2O'}{CaO'} \quad \cdots\cdots \quad \frac{85}{60} = 1.42$$

$$\frac{K_2O'}{Na_2O'} \quad \cdots\cdots \quad \frac{47}{38} = 1.24$$

According to the Quantitative System, the rock from Torigoé may be classified as a variety of shoshonose which is a transitional one from shoshonose to kentallenose, to which the kentallenite from Argyllshire and the absarokite from Yellowstone Park belong.

Classification.—It is evident that the rock is a variety of the monzonite group, owing to the presence of the two kinds of feldspar, soda orthoclase and calcic andesine, as essential ingredients. And the predominance of ferromagnesian minerals (augite, olivine and brown mica) may classify the rock as kentallenite (or olivine monzonite), although there are some differences from the original kentallenite from Argyllshire.[1] The original kentallenite has greenish augite, but the rock from Torigoé is characterized by the presence of the titaniferos variety. Their mutual relations will further be enlightened by their chemical characters.

As will be seen in the analyses given above, the chemical character of the kentallenite from Argyllshire and the absarokite from Yellowstone National Park are very close, as a whole, to that of the rock from Torigoé, and the absarokite shows still further close relation with the last rock. Slight differences between them, especially between the kentallenite from Torigoé from the other two rocks, rest essentially upon the relative amount of feldspar and ferromagnesian minerals, which caused the Torigoé rock to classify into the transitional variety from shoshonose to kentallenose. From the norms, we may obtain an approximate idea concerning the amount of feldspar contained in the Torigoé rock. The total amount of the feldspar is about 62 per-cent. of the rock mass. Among it soda orthoclase and calcic andesine (Ab_{47} An_{53}) exist in the proportion of 31.5 to 30.5

From the mineralogical and chemical characters as described above, the rock from Torigoé is a variety of kentallenite, which is somewhat different from the original kentallenite and is transitional toward the normal monzonite, but still more calcic and femic than the last one, and corresponds to an intrusive variety of absarokite-shoshonite effusive group.

1) J. B. HILL and H. KYNASTON: On Kentallenites and its Relations to other Igneous Rocks in Argyllshire. Q. J. G. S., Vol. LVI, 1900, P. 531.